



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Songlin Zhuang
Application No: 09/963,939
Filing Date: 09/26/2001
Title: LIQUID CRYSTAL BASED OPTICAL SWITCH UTILIZING
DIFFRACTION
Atty. Docket: BAO TONG-101

Examiner: Tarifur Rashid Chowdhury
Art Unit: 2871

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CERTIFICATE OF MAILING

I hereby certify that this correspondence is being deposited with the United States Postal Services as First Class Mail in an envelope addressed to the Commissioner of Patents & Trademarks, U. S. Patent and Trademark Office, P. O. Box 1450, Alexandria, VA 22313-1450 on October 3, 2003

By: Robert K. Tandler
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Reg. No.: 24,581
Attorney for Applicant
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RULE 131 DECLARATION

Commissioner of Patents & Trademarks
U.S. Patent and Trademark Office
P. O. Box 1450
Alexandria, VA 22313-1450

Sir:

I, Songlin Zhuang, declare as follows:

That I am the inventor of a Patent Application entitled LIQUID CRYSTAL BASED OPTICAL SWITCH UTILIZING DIFFRACTION, Serial No. 09/963,939 filed September 25, 2001.

That I am aware of U.S. Patent Publication US 2002/0097355A1, published July 25, 2002 and entitled High Contrast PDLC Transmission Gratings and Method of Manufacture.

That this patent publication relates to a Provisional Patent Application No. 60/249,679 filed on November 17, 2000.

RECEIVED
OCT 17 2003
TECHNICAL CENTER 2800

That my Patent Application was filed on September 26, 2001 and was the result of a conception before November 17, 2000.

That I am a professor at the University of Shanghai for Science and Technology and that I received my Ph.D degree from Pennsylvania State University on Mar. 1983 in the area of electro-optics.

That before November 17, 2000, I conceived the idea of providing a liquid crystal layer sandwiched between two plates, with the liquid crystal layer having a photopolymer dispersed throughout the liquid crystal layer as indicated by the upper left-most drawing on my laboratory notebook labeled p. 002, with the date of this laboratory notebook entry being before November 17, 2000.

That this laboratory notebook shows that with the application of a voltage across the liquid crystal layer, light entering from the left is diffracted off-axis by a controllable amount.

That laboratory notebook page 002 indicates serial use of liquid crystal layers so as to diffract an incoming light beam to one of four different spatial positions, depending on the voltages applied to two serial liquid crystal layers.

That subsequent to conceiving my invention, continuing work occurred to reduce the invention to practice.

That on December 15, 2000 my laboratory notebook at page 004 indicates further work on the diffraction of an incoming beam.

That on December 20, 2000 at page 005, my laboratory notebook shows reagents including activator and polymer to optimize the diffraction grating, including a method of making the liquid crystal layer.

That the above is an exact translation of page 005 of my laboratory notebook, a copy of which is provided herewith.

That on March 28, 2001, I described in my laboratory notebook at page 014 certain parameters for certain liquid crystal samples and the results of an experiment, and on May 8, 2001 an experimental procedure for adjusting the light path associated with diffraction switching.

That this page 014 is an exact translation of page 014 of my laboratory notebook, a copy of which is provided herewith.

That on June 6, 2001 I have a notice accepting a patent by the State Intellectual Property Office of P.R. China (SIPO) for an invention entitled Method of Realizing an $1 \times N$ and $n \times N$ Multi-optical Switch.

That on September 21, 2001, as indicated by page 035 of my laboratory notebook, an experiment was performed to determine further characteristics of the liquid crystal in terms of light path.

That page 035 is an exact translation of page 035 of my laboratory notebook, a copy of which is provided herewith.

That on September 26, 2001 I filed the subject Application.

That from the above, the invention of Claim 1 was conceived prior to November 17, 2000 and that work on the original project thereafter indicates that the invention was neither suppressed nor concealed nor was the invention abandoned.

That the invention was at least constructively reduced to practice on September 26, 2001 by the filing of the subject Application.

WHEREFORE Applicant requests that the reference entitled Publication No. US 2002/0097355A1 relating back to Provisional Patent Application No. 60/249,679 be withdrawn.

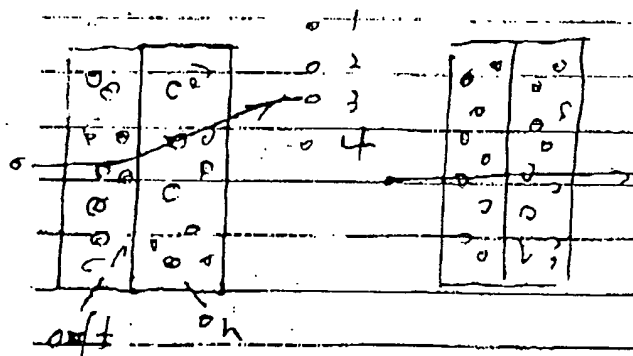
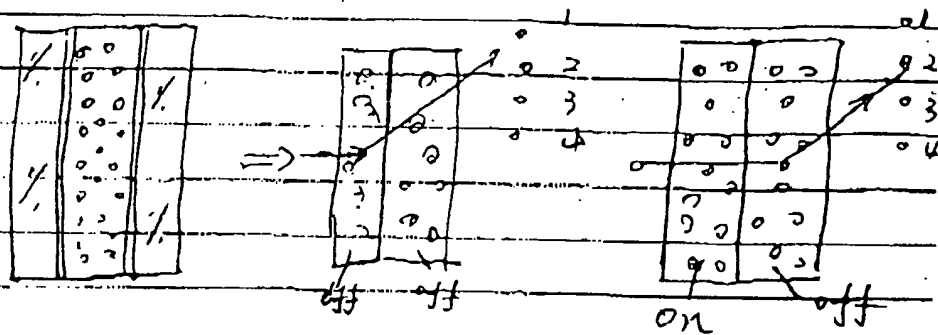
I further declare that all the statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the Application or any patent issuing thereon.



Songlin Zhuang

Date: 9/30/2003

002



在老师提出以上方案，经过大家讨论，一致同意方案3行。 张。

Dr. Zhuang bring the above project, and pass by the discussion, everybody agree with him. Gu.

004

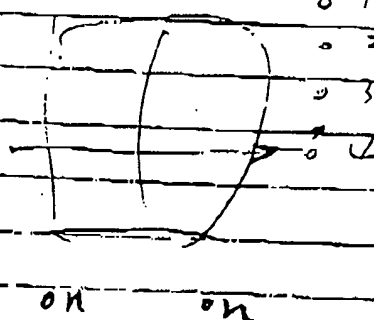
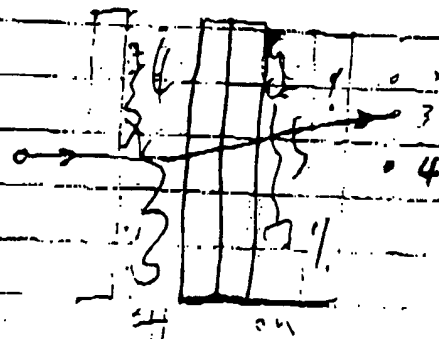
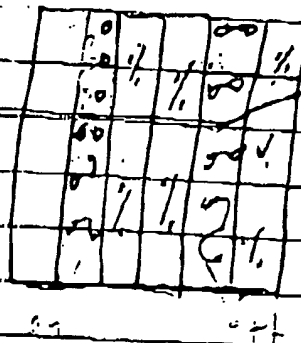
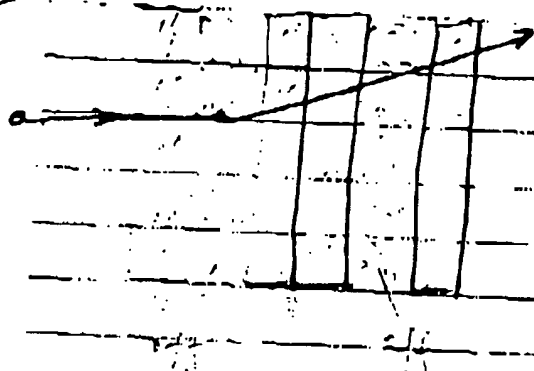
2000/12/15 星期五 Friday

12/15

12/15

output

output



Zhuang Gu Zheng

005

2020/12/20

Wed

12:30 ~ 20:00

1 weigh reagents

a) activator : $0.2553g \approx 250mg$

b) polymer 1 : 15g

∴ polymer: activator = 60:1

adjust the rate to 100:1 so 7.93g additional polymer needed

c) put into the Liquid Crystal 19.3g

d) the total amount reagents is $19.3 + 51.2 \approx 70.5g$

2 set up the Light path

The equipments are same to the teacher Wu which used to make concave holographic gratings, the He-Ne laser beams are expanded to sphere wave fronts and direct to the exposure area. By this means the ununiform interference fringes would form.

3 pump and print the ITO

heat up the mixture

put the Liquid crystal into the polymer, the thick polymer becomes watery, after pump it by a vacuum air pump, it will be more watery attach a glue strip onto the exposaler.

4 the time of exposure (PM 6:15 ~ PM 8:00) un-solidification

5 the remain mixture of polymer + liquid crystal + activator becomes thicker un-solidification

6 2020/12/21 PM 3:00 (before half an hour) the plate does not solidificate under daylight lamp

(Zhong Jihong record 12/21 AM)

005

2000/12/20

星期三 下午 12:30 ~ 20:00 Pm.

1. 称量试剂:

a) 聚活剂 $0.2553 \text{ g} = 250 \text{ mg}$ b) polymer 15 g polymer : 聚活剂 $= 60 : 1$

将比例调整至 100:1

 $\Delta P. 100 = 7.93 \text{ g}$ c) 加入 液氮 19.3 g d) 在烧杯中加好后总质量为 $51.2 + 19.3 = 70.5 \text{ g}$

2. 调整全息光路:

使用吴老师凹面全息光栅的实验装置 He-Ne 激光
 经过两棱镜透镜后成为球面波照射在曝光区域 将干涉条纹
 间距干涉条纹。

3. 抽真空与涂敷导电膜

Polymer 很稠, 加入液氮后搅拌均匀, 经过抽真空后全量稀
 用透明胶和双面胶沾于曝光器上

4. 曝光 T. PM 6:15 ~ PM 8:00 未固化.

5. 剩余的 P+液氮+胶 变得更稠, 未凝固

6. 于 2000/12/21 下午 3:00 (以前半小时) 曝光片在日光下固化

(郑健仁 记于 12/21 / 上午)

214

March 28

Wed.

	P ₁ B ₃ 2% sample	P ₂ B ₃ 2% sample	P ₃ B ₃ 2% sample
bottle weight	17.567 g	15.142 g	16.615 g
photoinitiator	30mg	30mg	30mg
polymer	P ₁ : 1.5g	P ₂ : 1.5g	P ₃ : 1.5g
Liquid crystal	1.5g	1.5g	1.5g
total weight	20.5 g	18.1 g	19.6 g

RT (15°C)

Laser power 400 mW

P₁B₃

12:50 ~ 1:05

appear solidification spot

~ 1:15

2 T

P₂B₃

1:15 ~ 1:40

un-solidificate (just a little)

P₃B₃

1:40 ~ 2:00

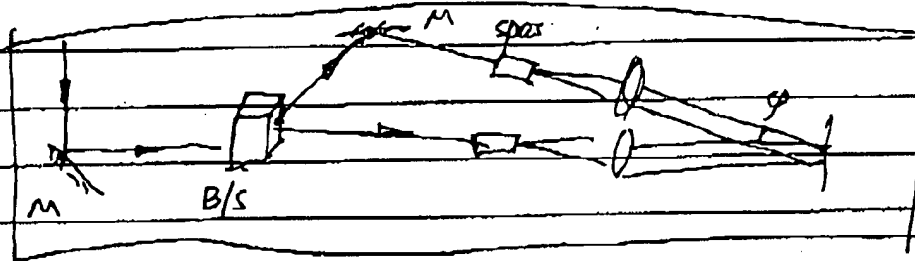
appear solidification

~ 2:10

solidificate but un-uniform

May 8.

adjust the Light path



014

3月28日

星期三

	P₁B₃ P ₁ B ₃ 2%样品	P ₂ B ₃ 2%样品	P ₃ B ₃ 2%样品
无盖称量瓶	17.547克	15.142克	16.615克
光敏剂 photo initiator	加 30mg	加 30mg	加 30mg
加	加 P ₁ 1.5克	加 P ₂ 1.5g	加 P ₃ 1.5g
加液晶	各 1.5克		
最后总重	20.5克	18.1克	19.6克

室温 15°C

激光功率 40mA

不 而 6-7mA

P₁B₃ 12:50 ~ 1:05 出现同化现象 (不明显)
~ 1:15 取T.

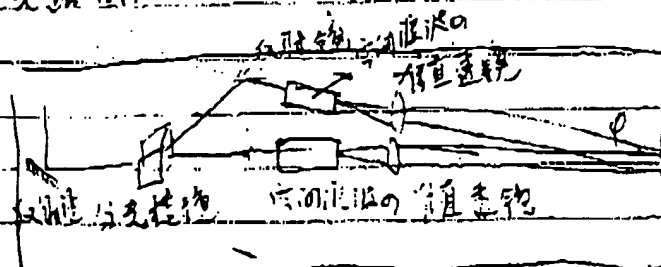
P₂B₃ 1:15 ~ 1:40 不同化 (只同化一点)

P₃B₃ ~~1:40~~ 1:40 ~ 2:00 出现同化现象
~ 2:30 同化 但不均匀

5月8日

调中全息光路

光路图



全息记录 光能损失较大

800A 入 30+25 mA 出

折 透

(安和光镜)

使用 1:1 光强比 全息记录效果较好

300nm/nm

φ 值 = 8°

035

9/21

P₃B₂ 2%

6-9% Liquid Crystal

T = 10 μ m

Laser power 40 mW

t = 21 min

$$\left\{ \begin{array}{l} 12.6 \\ 33.3 \end{array} \right.$$

$$\left\{ \begin{array}{l} 7.1 \\ 37.4 \end{array} \right.$$

t = 21.5 min

$$\left\{ \begin{array}{l} 13.2 \\ 26.8 \end{array} \right.$$

$$\left\{ \begin{array}{l} 6.4 \\ 32.0 \end{array} \right.$$

t = 22 min

$$\left\{ \begin{array}{l} 10.8 \\ 21.5 \end{array} \right.$$

$$\left\{ \begin{array}{l} 5.0 \\ 23.0 \end{array} \right.$$

t = 22.5 min

$$\left\{ \begin{array}{l} 8.5 \\ 15.7 \end{array} \right.$$

$$\left\{ \begin{array}{l} 5.0 \\ 17.4 \end{array} \right.$$

t = 23.5 min

$$\left\{ \begin{array}{l} 7.4 \\ 11.5 \end{array} \right.$$

$$\left\{ \begin{array}{l} 4.4 \\ 12.3 \end{array} \right.$$

left power 55°

right power 40°

~~material~~

and light path same to the above. Laser power = 25 mW

t = 32 min

$$\left\{ \begin{array}{l} 5.4 \\ 24.5 \end{array} \right.$$

$$\left\{ \begin{array}{l} 3.1 \\ 26.3 \end{array} \right.$$

t = 34 min

$$\left\{ \begin{array}{l} 3.0 \\ 23.6 \end{array} \right.$$

$$\left\{ \begin{array}{l} 3.1 \\ 20.9 \end{array} \right.$$

t = 36 min

$$\left\{ \begin{array}{l} 3.3 \\ 12.5 \end{array} \right.$$

$$\left\{ \begin{array}{l} 2.3 \\ 14.3 \end{array} \right.$$
P₃B₂ 2% 50% Liquid Crystal (Light path unchanged)T = 10 μ m

Laser power 28 mW

t = 32 min

$$\left\{ \begin{array}{l} 0.1 \\ 2.6 \end{array} \right.$$

$$\left\{ \begin{array}{l} 0.1 \\ 3.1 \end{array} \right.$$

t = 33 min

$$\left\{ \begin{array}{l} 0.1 \\ 2.3 \end{array} \right.$$

$$\left\{ \begin{array}{l} 0.1 \\ 3.1 \end{array} \right.$$

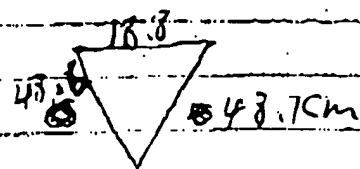
035

9月21日

P₃B₂ 2% 60% 液晶

T=10um

激光功率=40mw



t=21min

 $\begin{cases} 12.6 \\ 33.3 \end{cases}$
 $\begin{cases} 7.1 \\ 37.4 \end{cases}$

t=21.5min

 $\begin{cases} 13.2 \\ 26.8 \end{cases}$
 $\begin{cases} 6.4 \\ 32.0 \end{cases}$

t=22min

 $\begin{cases} 10.8 \\ 21.5 \end{cases}$
 $\begin{cases} 5.0 \\ 23.0 \end{cases}$

t=22.5min

 $\begin{cases} 8.5 \\ 15.7 \end{cases}$
 $\begin{cases} 5.0 \\ 11.4 \end{cases}$

t=23.5min

 $\begin{cases} 7.4 \\ 11.5 \end{cases}$
 $\begin{cases} 4.4 \\ 12.3 \end{cases}$

左边入射光 550

右边入射光 410

材料. 光路同上

激光功率=25mw

t=32min

 $\begin{cases} 5.4 \\ 24.5 \end{cases}$
 $\begin{cases} 3.1 \\ 28.3 \end{cases}$

t=34min

 $\begin{cases} 2.0 \\ 23.6 \end{cases}$
 $\begin{cases} 3.1 \\ 20.9 \end{cases}$

t=36min

 $\begin{cases} 3.3 \\ 12.5 \end{cases}$
 $\begin{cases} 2.3 \\ 14.3 \end{cases}$
P₃B₂ 2% 50% 液晶

光路不变

T=10um

激光功率=25mw

t=32min

 $\begin{cases} 0.1 \\ 2.6 \end{cases}$
 $\begin{cases} 0.1 \\ 3.1 \end{cases}$

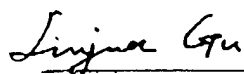
t=33min

 $\begin{cases} 0.1 \\ 2.3 \end{cases}$
 $\begin{cases} 0.1 \\ 3.0 \end{cases}$

CORROBORATING STATEMENT

The description of the drawing in lab notebook page 002

The drawing of the device in lab notebook page 002 describe the concept of optical switch based on polymer dispersed liquid crystal (PDLC). The PDLC material is sandwiched by two glass with ITO layer. A holographic grating can be written on the PDLC device by using interference method of two laser beams. When the voltage is applied cross the device the grating will disappear. Then the device becomes glass plat. The grating appears again as soon as the voltage is released. This function of the PDLC device can be utilized to establish a optical switch. The dots on the drawing of the device refer to PDLC material.



Lingjuan Gu

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University of Shanghai for Sci. & Tech.